low capacity channels **8855** through which the intended destination for the respective data units can be reached.

The SONET network can perform at least one of SONET switching, SONET multiplexing, and SONET de-multiplexing. In a possible embodiment, SONET switching is implemented by using at least one of time driven switching (TDS) technology and time driven priority technology, as described above in this disclosure.

From the foregoing, it will be observed that numerous variations and modifications may be effected without departing from the spirit and scope of the invention. It is to be understood that no limitation with respect to the specific apparatus illustrated herein is intended or should be inferred. It is, of course, intended to cover by the appended claims all such modifications that fall within the scope of the claims.

WHAT IS CLAIMED IS:

1. A switching system having an input and an output, each of the input and the output comprising at least one channel coupled for communicating data units, the switching system further comprising:

a first communications switch and a second communications switch connected by at least one communications link, comprising at least one channel, for transmitting a plurality of data units from said communications link to the output of the switching system;

a Common Time Reference (CTR), divided into a plurality of contiguous time frames (TFs);

wherein the time frames have at least one of a plurality of predefined time durations;

wherein each of the communications switches is further comprised of a plurality of input ports and a plurality of output ports, each of the input ports connected to and receiving data units from at least one of the channels, and each of the output ports connected and transmitting data units to at least one of the channels;

wherein each of the communications switches has a switch controller, coupled to the CTR, the respective input ports, and the respective output ports;

wherein each of the first and second communications switches has a switch fabric coupled to the respective switch controller, the respective input ports, and the respective output ports; and

wherein each of the switch controllers is responsive to the CTR and to the respective predefined time durations of respective ones of the time frames, for scheduling a connection via the switch fabric from a respective one of the input ports, on a respective one of the input channels during a predefined time interval.

2. The system as in claim 1, wherein each of the switch controllers defines the coupling from each one of the respective input ports for data units received during any one of the time frames, on a respective one of the channels, for output during a predefined time frame to at least one selected one of the respective output ports on at least one selected respective one of the channels.

3. The system as in claim 2, wherein the data units that are output through the switch fabric during a first predefined time frame on a selected respective one of the channels through the respective output port on the first communications switch are forwarded through the respective output port of the second communications switch during a second predefined time frame on a selected respective one of the channels responsive to the CTR.

4. The system as in claim 3, wherein the first and second predefined time frames are of different time durations.

5. The system as in claim 1, wherein the data units received at multiple ones of the channels during a first one of the predefined time frames are combined for output during a second one of the predefined time frames responsive to the switch controller.

6. The system as in claim 1, wherein the data units received at a single one of the channels during a plurality of the predefined time frames are combined for output to a second one of the channels during a second predefined time frame.

7. The system as in claim 5, wherein the first one and the second one of the predefined time frames have different durations.

8. The system as in claim 5, wherein a plurality of the first ones of the predefined time frames have a plurality of different time durations.

9. The system as in claim 6, wherein at least two of the plurality of the predefined time frames are of different durations.

10. The system as in claim 6, wherein at least one of the plurality of the predefined time frames have a different duration than the second predefined time frame.

11. The system as in claim 1, wherein the time frames are each comprised of at least one sub-time frame.

12. The system as in claim 11, wherein each of the sub-time frames is of lesser duration than the time frames.

13. The system as in claim 11, wherein the switch controller schedules the transfer of the data units received during at least one of a plurality of the sub-time frames, for output during a different one of the sub-time frames.

14. The system as in claim 1, wherein the channel is at least one of optical channel, wireless channel, wavelength division multiplexing channel, frequency division multiplexing channel, sub-carrier multiplexing channel, and copper wire channel.

15. The system as in claim 1, wherein the data units are at least one of bytes, words, data packets, and cells.

16. The system as in claim 1, wherein during selected ones of the time frames at least one data unit is transmitted over the channel.

17. The system as in claim 11, wherein a predefined number of at least one consecutive one of the time frames comprise a time cycle, wherein a predefined number of at least one consecutive one of the time cycles comprise a super cycle.

18. The system as in claim 17, wherein the switch controller schedules the transfer of data units from and to selected ones of the channels on a periodically recurring basis.

19. The system as in claim 18, wherein the periodically recurring basis is at least one of (a) every time cycle, and (b) every super cycle.

20. The system as in claim 3, wherein the time difference between the first predefined time frame and the second predefined time frame is a predefined time interval.

21. The system as in claim 20, wherein the predefined time interval is a plurality of first predefined time frames.

22. The system as in claim 20, wherein the predefined time interval is a plurality of second predefined time frames.

23. The system as in claim 20, wherein the predefined time interval is a plurality of first predefined time frames and second predefined time frames.

24. The system as in claim 11, wherein consecutive sub-time frames are separated by a sub-time frame delimiter.

25. The system as in claim 11, wherein the all sub-time frames are of equal time duration.

26. The system as in claim 11, wherein each of the sub-time frames within the time frame can have an arbitrary duration.

27. The system as in claim 1,

wherein the switch fabric is at least one of the following: a crossbar, a generalized multi-stage cube network, a Clos network, a Benes network, an Omega network, a Delta network, a multi-stage shuffle exchange network, a Banyan network, a combination of demultiplexers and multiplexers, a passive optical star, a plurality of passive optical stars, a plurality of tunable lasers, a plurality of tunable lasers connected to at least one passive optical star, a plurality of optical tunable receivers connected to at least one passive optical star, and an optical switch.

28. The system as in claim 1,

wherein the plurality of input ports each receives data units over at least one of a plurality of incoming channels (j), and wherein the plurality of output ports each sends data units over at least one of a plurality of outgoing channels (l);

wherein each of the incoming channels (j) has a unique time reference (UTR-j) that is phase independent of the CTR;

wherein the UTR-j is divided into continuous UTR-j super cycles; wherein the UTR-j super cycles are divided into continuous UTR-j time cycles; and wherein the UTR-j time cycles are divided into continuous UTR-j time frames; and

wherein the UTR-j time frames have a plurality of predefined time durations.

29. The system as in claim 28,

wherein the UTR-j time frames have at least one of the following: same duration as the CTR time frames, and different duration than the CTR time frames.

30. The system as in claim 28,

wherein the UTR-j time cycles have at least one of the following: same duration as the CTR time cycles, and different duration than the CTR time cycles.

31. The system as in claim 28,

wherein the UTR-j super cycles have at least one of the following: same duration as the CTR super cycles, and different duration than the CTR super cycles.

32. The system as in claim 28,

wherein the UTR-j super cycles have a starting time and an ending time that is at least one of: (1) different starting time and ending time than the CTR super cycles; and (2) same starting time and ending time as the respective CTR super cycles.

33. The system as in claim 28,

wherein the UTR-j time cycles have a starting time and an ending time that are at least one of: (1) different starting time and ending time than the CTR time cycles; and (2) same starting time and ending time as the respective CTR time cycles.

34. The system as in claim 28, further comprising:

a plurality of buffer queues, wherein each of the respective buffer queues is associated, for each of the CTR time frames, with a combination of one of the incoming channels and one of the outgoing channels;

a mapping controller within the switch controller system for logically mapping, for each of the (UTR-j) time frames, selected incoming channels (j) to selected buffer

queues, and for logically mapping, for each of the CTR time frames, selected ones of the plurality of buffer queues to selected outgoing channels (l);

wherein each of the buffer queues is further comprised of an alignment subsystem comprised of a plurality of time frame queues, wherein each of the time frame queues comprises means to determine that the respective time frame queue is empty, wherein each of the time frame queues further comprises means to determine that the respective time frame queue is not empty;

wherein the data units that arrive via the incoming channel (j) are stored in the respective time frame queue of the alignment subsystem responsive to the mapping controller; and

wherein the mapping controller further provides for coupling of selected ones of the time frame queues to respective ones of the outgoing channels (l), for transfer of the respective stored data units during the respective associated time CTR time frames.

35. The system as in claim 34,

wherein the alignment subsystem, responsive to the mapping controller, transfers the data units associated with a respective first time frame as defined by the UTR-j into an empty first time frame queue from incoming channel (j), during the respective first time frame as defined by the UTR-j , wherein the first time frame queue is designated as full; and

wherein the alignment subsystem, responsive to the mapping controller, transfers data units out of a full second time frame queue to outgoing channel (l), during at least one of the following: a selected one of the CTR time frames and a selected one of the CTR sub-time frames, wherein the second time frame queue is designated as empty.

36. The system as in claim 35,

wherein the first time frame queue and the second time frame queue are mutually exclusive at all times.

37. The system as in claim 28,

wherein the UTR-j time frames have at least two different time durations.

38. The system as in claim 35,

wherein during one CTR time frame data units are transferred from at least two predefined time frame queues.

39. The system as in claim 35,

wherein during one CTR time frame data units are transferred from a predefined part of the second time frame queue.

40. The system as in claim 35,

wherein during one CTR time frame data units are transferred from at least two predefined time frame queues on at least two different outgoing channels.

41. A system for scheduling and managing data transfer of data units, said system comprising:

a switch with plurality of input ports each with a plurality of input channels and plurality of output ports each with a plurality of output channels for receiving and transmitting the data units;

a common time reference (CTR) signal coupled to said switch;

wherein the common time reference is partitioned into time frames, and wherein the transfer of the data units is provided during respective ones of a plurality of the time frames;

wherein the time frames have at least one predefined duration;

wherein the time frames at each of the input channels is grouped into time cycles, wherein each of the time frame durations at each of the input channels is one of a plurality of predefined durations;

wherein the time frames at each of the output channels are grouped into time cycles, wherein each of the time frame durations at each of the output channels is one of a plurality of predefined durations; and

a switch fabric for coupling incoming data units between selected ones of the input channels and the output channels, wherein each of the selected input channels is associated with an associated first time frame duration, and wherein each of the selected output channels is associated with an associated second time frame duration.

42. The systems as in claim 41,

wherein a predefined number (i1) of contiguous time frames of duration (d1) at a first input channel are grouped into a time cycle (ic1), wherein (i1) is at least equal to 1;

wherein a predefined number of contiguous time frames (i2) of duration (d2) at a second input channel are grouped into a time cycle (ic2), wherein (i2) is at least equal to 1;

wherein a predefined number of contiguous time frames (i3) of duration (d3) at a third input channel are grouped into a time cycle (ic3), wherein (i3) is at least equal to 1;

wherein a predefined number of contiguous time frames (o1) of duration (t1) at a first output channel are grouped into a time cycle (oc1), wherein (o1) is at least equal to 1;.

wherein a predefined number of contiguous time frames (o2) of duration (t2) at a second output channel are grouped into a time cycle (oc2), wherein (o2) is at least equal to 1;

wherein a predefined number of contiguous time frames (o3) of duration (t3) at a third output channel are grouped into a time cycle (oc3), wherein (o3) is at least equal to 1; and

wherein the scheduling of data units on the input channels and output channels of the switch have a plurality of predefined mappings from: selected ones of the i1, i2, and i3 time frames during respective time cycles ic1, ic2, and ic3, to selected ones of the o1, o2, and o3 time frames during respective time cycles oc1, oc2, and oc3.

43. The system as in claim 41, further comprising of:

a plurality of input links each with a plurality of input wavelengths;

means for separating out the input wavelengths carried in each of the input links, to provide separated input wavelength signals; and

means for mapping a selected one of the separated input wavelength signals to each of the input channel.

44. The system as in claim 43, wherein the separated input wavelength signals of each of the input links are mapped to input channels of at least one input port.

45. The system as in claim 41, further comprising of:

a plurality of output links each with a plurality of output wavelengths;

means for mapping each of the output channels to a selected one of a plurality of output wavelength signals; and

means for combining selected ones of the output wavelength signals for transmission over each of the output links, to provide combined output wavelengths.

46. The system as in claim 45, wherein the combined output wavelengths of each of the output links are comprised of output wavelength signals mapped from output channels of at least one output port.

47. The system as in claim 45, further comprising of:

a rate matching buffer; and

wherein the rate matching buffer (RMB) is coupling selected ones of the plurality of output channels and selected ones of the plurality of output wavelength signals.

48. The system as in claim 47,

wherein the RMB is further comprised of a plurality of queues and an RMB controller;

wherein the RMB controller is responsive to the CTR for storing the data units during selected ones of the time frames in selected ones of the queues; and

wherein the RMB controller is responsive to the CTR for retrieving the data units during selected ones of the time frames from selected ones of the queues for transmission over at least one of the selected ones of the plurality of output wavelength signals.

49. The system as in claim 47,

wherein the RMB is coupled to one output wavelength signal and to at least one of the following: one output channel, two output channels, four output channels, eight output channels, sixteen output channels, and thirty two output channels.

50. The system as in claim 47,

wherein the RMB is coupled to one output channel and to at least one of the following: one output wavelength signal, two output wavelength signals, four output wavelength signals, eight output wavelength signals, sixteen output wavelength signals, and thirty two output wavelength signals.

51. A switching method for use with a switching system having an input and an output, each of the input and the output comprising at least one channel coupled for communicating data units, the switching system further comprising a first communications switch and a second communications switch connected by at least one communications link, comprising at least one channel, for transmitting a plurality of data units from said communications link to the output of the switching system, wherein each of the communications switches is further comprised of a plurality of input ports and a plurality of output ports, each of the input ports connected to and receiving data units from at least one of the channels, and each of the output ports connected and transmitting data units to at least one of the channels, the method comprising:

providing a Common Time Reference (CTR);

dividing the CTR into a plurality of contiguous time frames (TFs); wherein the time frames have at least one of a plurality of predefined time durations; and

scheduling a connection from a respective one of the input ports, on a respective one of the input channels during a predefined time interval, responsive to the CTR and to the respective predefined time durations of respective ones of the time frames.

52. The method as in claim 51, further comprising:

defining the coupling from each one of the respective input ports for data units received during any one of the time frames, on a respective one of the channels, for output during a predefined time frame to at least one selected one of the respective output ports on at least one selected respective one of the channels.

53. The method as in claim 52, further comprising:

outputting the data units during a first predefined time frame on a selected respective one of the channels through the respective output port on a first communications switch; and

forwarding through the respective output port of a second communications switch during a second predefined time frame on a selected respective one of the channels, responsive to the CTR.

54. The method as in claim 51, wherein the time frames are each comprised of at least one sub-time frame.

55. The method as in claim 54, wherein each of the sub-time frames is of lesser duration than the time frames.

56. The method as in claim 54, the method further comprising:

scheduling the transfer of the data units received during at least one of a plurality of the sub-time frames, for output during a different one of the sub-time frames.

57. The method as in claim 54, wherein consecutive sub-time frames are separated by a sub-time frame delimiter.

58. A method for scheduling and managing data transfer of data units within a system comprising a switch with plurality of input channels and plurality of output channels for receiving and transmitting the data units, the method comprising:

providing a common time reference (CTR) signal coupled to said switch;

partitioning the common time reference into time frames, each having at least one predefined duration;

grouping each of the time frames at each of the input channels into time cycles, wherein each of the time frame durations at each of the input channels has one of a plurality of predefined durations;

grouping the time frames at each of the output channels into time cycles, wherein each of the time frame durations at each of the output channels has one of a plurality of predefined durations;

coupling incoming data units between selected ones of the input channels and the output channels, wherein each of the selected input channels is associated with an associated first time frame duration, and wherein each of the selected output channels is associated with an associated second time frame duration; and

transferring the data units during respective ones of a plurality of the time frames.

59. The method as in claim 58, further comprising:

grouping a predefined number (i1) of contiguous time frames of duration (d1) at a first input channel into a time cycle (ic1), wherein (i1) is at least equal to 1;

grouping a predefined number of contiguous time frames (i2) of duration (d2) at a second input channel into a time cycle (ic2), wherein (i2) is at least equal to 1;

grouping a predefined number of contiguous time frames (i3) of duration (d3) at a third input channel into a time cycle (ic3), wherein (i3) is at least equal to 1;

grouping a predefined number of contiguous time frames (o1) of duration (t1) at a first output channel into a time cycle (oc1), wherein (o1) is at least equal to 1;.

grouping a predefined number of contiguous time frames (o2) of duration (t2) at a second output channel into a time cycle (oc2), wherein (o2) is at least equal to 1;

grouping a predefined number of contiguous time frames (o3) of duration (t3) at a third output channel into a time cycle (oc3), wherein (o3) is at least equal to 1;

scheduling the transfer of data units on the input channels and output channels of the switch in accordance with a plurality of predefined mappings from: selected ones of the i1, i2 and i3 time frames during respective time cycles ic1, ic2 and ic3, to selected ones of the o1, o2 and o3 time frames during respective time cycles oc1, oc2 and oc3.

60. The method as in claim 58, wherein the system is further comprised of a plurality of input links each with a plurality of input wavelengths, the method further comprising:

separating out the input wavelengths carried in each of the input links, to provide separated input wavelength signals; and

mapping a selected one of the separated input wavelength signals to each of the input channels.

61. The method as in claim 60, further comprising:

mapping the separated input wavelength signals of each of the input links to input channels of at least one input port.

62. The method as in claim 58, wherein the system is further comprised of a plurality of output links each with a plurality of output wavelengths, the method further comprising:

mapping each of the output channels to selected one of the output wavelength signals; and

combining the selected ones of the output wavelength signals for transmission over each of the output links, to provide combined output wavelengths.

63. The method as in claim 62, further comprising: mapping from output wavelength signals to output channels of at least one output port, to provide the combined output wavelengths of each of the output links.

64. The method as in claim 62, further comprising:

coupling selected ones of the plurality of output channels and selected ones of the plurality of output wavelength signals.

65. The method as in claim 64, wherein the system is further comprised of a plurality of queues, the method further comprising:

storing the data units within selected ones of the time frames in selected ones of the queues responsive to the CTR; and

retrieving the data units within selected ones of the time frames from selected ones of the queues for transmission over at least one of the selected ones of the plurality of output wavelength signals responsive to the CTR.

66. The method as in claim 64, further comprising:

coupling at least one output wavelength signal to at least one of the following: one output channel, two output channels, four output channels, eight output channels, sixteen output channels, and thirty two output channels.

67. The method as in claim 64, further comprising:

coupling at least one output channel and to at least one of the following: one output wavelength signal, two output wavelength signals, four output wavelength signals, eight output wavelength signals, sixteen output wavelength signals, and thirty two output wavelength signals.